INTRODUCTION

This report is being submitted to the Michigan Legislature and the State Transportation Commission in accordance with the provisions of MCL 247.659a. The purpose of the report is to inform both bodies of the current condition of Michigan's federal-aid eligible public roads and bridges and the recent activities of the Transportation Asset Management Council.

From Needs Studies to Asset Management

Act 499 of 2002 amended Section 9a of MCL 247.659. This section, since 1972, required the development of a "needs study" on a four-year basis. Act 499 eliminated the requirement of a regular needs study and replaced it with an asset management process.

Needs studies had several key objectives. First, they provided elected officials and the public, in a single volume, an inventory of the highway system and the revenues needed to retire the identified deficiencies. Second they served as a backdrop to establish revenue increases and to determine the distribution of funds amongst transportation providers.

Michigan conducted several needs studies during the 1970s but the most extensive one was done in 1983. The 1983 study included all modes and covered the period of 1983 through 1994.

There were many problems with the needs study process in Michigan and consequently the 1983 study was the last one done in the state. First, the funds needed to retire the deficiencies appeared to be staggering. Highway and bridge needs alone were in excess of $22 billion. Capital outlay needs were $13 billion. Second, it was assumed that all needs were of equal importance. Repaving a two-lane rural road carrying 200 vehicles a day was considered to be of same importance as repaving a freeway. There simply was no prioritization of the needs. The Legislature had no idea which needs were of more importance to the economy and welfare of the state. Consequently, it was impossible to use the information for any type of long-range planning. Third, there were no standards identified, nor performance measures to determine whether or not the goal of achieving improved mobility had been achieved. And there was no monitoring mechanism in place to ensure the dollars were being spent on the needs. Finally, the law did not define "needs" and seemed to imply that there was a direct correlation between the needs and the distribution of transportation funds. The fact of the matter is that in the entire history of needs studies in Michigan there has been no correlation between the identified needs and the distribution of road funds. The needs studies were never used to make decisions about changing the allocation of funding.

In 1998, the Legislature passed Public Act 308 which created the Act 51 Transportation Funding Study Committee. This committee was called upon to study transportation funding issues, to weigh information from affected agencies and interest groups, and make recommendations for the future. After meeting for about 14 months, the committee issued its final report, ***Transportation Funding for the 21st Century***. The major recommendation coming from the committee was that a long-range asset management process be established to manage Michigan's transportation infrastructure.

During the session of 2001-2002, the Legislature acted upon the committee's recommendations and created the Transportation Asset Management Council. Their

mission, according to the law is to advise the State Transportation Commission on a statewide asset management strategy and the necessary procedures and tools to implement that strategy. The Council has been meeting monthly since October 2002.

The major philosophical change that has taken place with the passage of this law is to look at the road system holistically rather than as individual projects.

ELEMENTS OF ASSET MANAGEMENT

The major elements of an asset management system are:

- Establishing goals and objectives through development of a strategic plan,
- Collecting data to measure progress toward achieving the established goals and objectives,
- Using management systems to control the various processes,
- Developing appropriate performance measures,
- Identifying standards and benchmarks,
- Developing alternative analyses procedures,
- Making decisions based on these results and developing an appropriate program,
- Implementing the program,
- Monitoring and reporting results of actions taken.

Traditionally, public sector management of roads and bridges has been tactical in nature, concentrating on the immediate and most severe problems. Asset management shifts that thinking to one that is strategic in nature. Decisions are made with regard to the long-range condition of the entire system. This requires considering various investment strategies which will maintain the assets in good condition.

It is crucial in an asset management process to have the ability to forecast future road and bridge conditions and to do investment analyses based on various funding scenarios. The strategic component of the decision-making process entails the ability to assess improvements based on desired outcomes. The strategic focus of an asset management process is supported by network level analysis in addition to the tactical focus of performing location-specific, project-level analysis. This task would include consideration of:

- Current condition of the transportation system and future condition if there is no change in current practices;
- Future condition based on alternative strategies;
- The right time to maintain, preserve, or improve to get maximum useful life from a transportation asset;
- Use preventive fixes or allow an asset to deteriorate to the point of requiring reconstruction;
- Costs and benefits of each decision; and
- Relationship to identified goals and objectives.

The key is the conscious effort required to create and analyze alternatives. It is necessary to focus attention on effectively and efficiently managing and operating our transportation system, rather than merely reconstructing it.

Elements Of Pavement Management

Once a road has been constructed or reconstructed, the condition of the pavement will begin to change over time, due to the effects of weather, environmental factors and traffic loads. Weather factors include the amount of rain/snow, temperatures (particularly extreme heat and cold), humidity, freeze-thaw cycles, exposure to sunlight, etc. Environmental factors include soil types. Traffic load includes some function of traffic frequency and the weight of the vehicles.

There are also combined effects between these two main factors. Heavy and frequent traffic loadings while the pavement is more vulnerable due to severe weather will cause more damage than the same loadings during favorable weather. In addition, several other factors can contribute to the rate at which pavement deteriorates. These include:

- Type, condition, and moisture content of the sub grade soil,
- Type, thickness, and strength of the base materials,
- Timing of preventive maintenance fixes, and
- Quality of construction.

According to the American Association of State Highway and Transportation Officials (AASHTO): "Those who work with pavements know that after a pavement is built, traffic and environmental loadings create unavoidable stress that will eventually reduce the condition of the roads to a point where they will not be usable without maintenance. They also know that early treatment will extend the life of some pavement."[1]

Preventive maintenance programs are designed to extend the life of good pavements by applying low cost, short term treatments. Preventive maintenance projects are low cost projects intended to protect an existing pavement structure, slow the rate of pavement deterioration, and/or correct overall deficiencies in the pavement surface. The benefit of preventive maintenance activity can best be realized if an agency applies treatments to a pavement in good condition. Preventive maintenance treatments cannot be targeted to the worst roads, but must be made to those in fair or good condition which have defects that if left unattended would require much more costly repairs.

The challenge for most agencies is to determine when in the life of a pavement is the best time to apply a preventive maintenance treatment for the maximum benefit. Preventive maintenance is perhaps the single most influential component in the network strategy, that allows an agency to manage pavement conditions. It creates the ability to postpone costly reconstruction or rehabilitation activities, by extending the remaining service life of the original pavement.

A significant benefit of a comprehensive preventive maintenance program is that it gives managers control over future network conditions and funding requirements. By controlling future network conditions, decision makers can anticipate routine maintenance work loads, safety deficiencies, and ride quality needs. Several studies have found that a dollar invested in preventive maintenance will save from $4 to $6 in future reconstruction or rehabilitation costs.

[1] "Executive Summary Report: Pavement Management Guide," AASHTO, November 2001, pp. 1-2.

PAVEMENT DETERIORATION

"The rate at which pavement deteriorates depends on its environmental, traffic loading conditions, original construction quality, and interim maintenance procedures. Poor quality materials or poor construction procedures can significantly reduce the life of a pavement. Therefore, two pavements constructed at the same time may have significantly different lives, or certain portions of a pavement may deteriorate more rapidly than others, due to material or construction problems. On the other hand, timely and effective maintenance can extend the life of a pavement. Crack sealing and seal coating can reduce the effect of moisture in aging of asphalt pavement. With all these variables, it is easy to see why pavements deteriorate at various rates and why we find pavements in various stages of repair … Once significant deterioration begins it is common to see pavements deteriorate rapidly. This is usually due to a combination of loading and the effects of additional moisture. As a pavement ages and additional cracking develops, more moisture can enter the pavement and accelerate the rate of deterioration."

Asphalt – PASER Manual, Transportation Information Center, University of Wisconsin-Madison, 1996, pp. 4, 16.

Pavement Analysis & Overview of PASER

The American Association of State Highway and Transportation Officials (AASHTO) identifies four methods of determining pavement condition.[2]

Surface Distress is damage to the pavement surface. Distress surveys are performed to determine the type, severity, and quantity of observable surface distress.

Structural Capacity deals with the maximum load and the number of repetitions a pavement is predicted to carry. Structural analysis is normally conducted to determine the current pavement load-carrying capacity which can be compared to the capacity needed to accommodate projected traffic.

Roughness (ride quality) is a measure of pavement surface distortion or an estimate of the ability of the pavement to provide a comfortable ride to the users.

Surface Friction or Skid Resistance is the ability of the pavement surface to provide sufficient friction to avoid skid-related safety problems, especially in wet weather.

One of the most critical concerns raised during the Act 51 Transportation Funding Study Committee's deliberations was that there were a myriad of numbers being used to describe the condition of our roads. The reason for the different numbers is related to which of the above methods is being used to determine pavement condition. For instance, the International Roughness Index (IRI) measures roughness. This is what is reported in the TRIP report each year. There is remaining surface life which is used by several agencies including MDOT. There is a pavement condition index or PCI. Both remaining surface life and PCI combine elements of surface distress and structural capacity. And there is PASER, a surface condition analysis used by most of the road agencies throughout Michigan. And while the tendency is to compare these different methods, the truth is they do not measure the same conditions and should not be compared. The Act 51 Transportation Funding Study Committee stressed the need for policy makers to have one method and one method only.

[2] "Executive Summary Report: Pavement Management Guide," AASHTO, November 2001, p. 7.

The Council chose the **Pavement Surface Evaluation and Rating System** (PASER) because it is easy to collect; is of sufficient detail for statewide, network-level analysis; and is the method currently used by most road agencies in Michigan. PASER is a visual survey. It rates the condition of various types of pavement distress on a scale of 1-10. It is based on a system of pavement evaluation developed in Wisconsin and is used by most road agencies in that state.

The Transportation Information Center, University of Wisconsin-Madison has published a series of manuals associated with ratings for different types of surfaces. The manuals are "designed to provide background information on asphalt pavement conditions and causes of distress as well as a simple procedure to rate pavement condition."[3] There are also manuals for concrete, gravel, brick, etc.

PASER is the rating method used by RoadSoft, which is the predominant pavement management software in use throughout Michigan. The Council chose to rate Michigan's roads using the PASER rating method, for the first three years. After that time, a different rating method could be considered.

As mentioned, PASER is a visual, windshield survey. This type of survey is one of the easiest to do and is relatively inexpensive compared to other rating methods. This makes it ideal for small agencies.

While PASER is a subjective method it is based on sound engineering principles. PASER measures "surface distress." It does not measure structural capacity, ride quality or friction.

PASER uses 10 separate ratings. There are different ratings for different surfaces based on the types of deterioration that is evident. The Appendix contains photos from the various PASER manuals for all ratings for asphalt, concrete, and gravel surfaces. For the Council's purposes these ratings have been grouped into three work-related improvement categories.

Routine Maintenance

Routine maintenance is the day-to-day regularly-scheduled activities to prevent water from seeping into the surface such as street sweeping, drainage clearing, gravel shoulder grading, repairing potholes, and sealing cracks. PASER ratings 8, 9, 10 are included in this category. The following pictures show the types of roads that require routine maintenance. This category includes roads that are newly constructed or recently seal coated. They require little or no maintenance. All cracks are sealed tightly.

[3] **Asphalt – PASER Manual**, Transportation Information Center, University of Wisconsin-Madison, November 1996

INTRODUCTION

This report is being submitted to the Michigan Legislature and the State Transportation Commission in accordance with the provisions of MCL 247.659a. The purpose of the report is to inform both bodies of the current condition of Michigan's federal-aid eligible public roads and bridges and the recent activities of the Transportation Asset Management Council.

From Needs Studies to Asset Management

Act 499 of 2002 amended Section 9a of MCL 247.659. This section, since 1972, required the development of a "needs study" on a four-year basis. Act 499 eliminated the requirement of a regular needs study and replaced it with an asset management process.

Needs studies had several key objectives. First, they provided elected officials and the public, in a single volume, an inventory of the highway system and the revenues needed to retire the identified deficiencies. Second they served as a backdrop to establish revenue increases and to determine the distribution of funds amongst transportation providers.

Michigan conducted several needs studies during the 1970s but the most extensive one was done in 1983. The 1983 study included all modes and covered the period of 1983 through 1994.

There were many problems with the needs study process in Michigan and consequently the 1983 study was the last one done in the state. First, the funds needed to retire the deficiencies appeared to be staggering. Highway and bridge needs alone were in excess of $22 billion. Capital outlay needs were $13 billion. Second, it was assumed that all needs were of equal importance. Repaving a two-lane rural road carrying 200 vehicles a day was considered to be of same importance as repaving a freeway. There simply was no prioritization of the needs. The Legislature had no idea which needs were of more importance to the economy and welfare of the state. Consequently, it was impossible to use the information for any type of long-range planning. Third, there were no standards identified, nor performance measures to determine whether or not the goal of achieving improved mobility had been achieved. And there was no monitoring mechanism in place to ensure the dollars were being spent on the needs. Finally, the law did not define "needs" and seemed to imply that there was a direct correlation between the needs and the distribution of transportation funds. The fact of the matter is that in the entire history of needs studies in Michigan there has been no correlation between the identified needs and the distribution of road funds. The needs studies were never used to make decisions about changing the allocation of funding.

In 1998, the Legislature passed Public Act 308 which created the Act 51 Transportation Funding Study Committee. This committee was called upon to study transportation funding issues, to weigh information from affected agencies and interest groups, and make recommendations for the future. After meeting for about 14 months, the committee issued its final report, ***Transportation Funding for the 21st Century***. The major recommendation coming from the committee was that a long-range asset management process be established to manage Michigan's transportation infrastructure.

During the session of 2001-2002, the Legislature acted upon the committee's recommendations and created the Transportation Asset Management Council. Their

mission, according to the law is to advise the State Transportation Commission on a statewide asset management strategy and the necessary procedures and tools to implement that strategy. The Council has been meeting monthly since October 2002.

The major philosophical change that has taken place with the passage of this law is to look at the road system holistically rather than as individual projects.

ELEMENTS OF ASSET MANAGEMENT

The major elements of an asset management system are:

- Establishing goals and objectives through development of a strategic plan,
- Collecting data to measure progress toward achieving the established goals and objectives,
- Using management systems to control the various processes,
- Developing appropriate performance measures,
- Identifying standards and benchmarks,
- Developing alternative analyses procedures,
- Making decisions based on these results and developing an appropriate program,
- Implementing the program,
- Monitoring and reporting results of actions taken.

Traditionally, public sector management of roads and bridges has been tactical in nature, concentrating on the immediate and most severe problems. Asset management shifts that thinking to one that is strategic in nature. Decisions are made with regard to the long-range condition of the entire system. This requires considering various investment strategies which will maintain the assets in good condition.

It is crucial in an asset management process to have the ability to forecast future road and bridge conditions and to do investment analyses based on various funding scenarios. The strategic component of the decision-making process entails the ability to assess improvements based on desired outcomes. The strategic focus of an asset management process is supported by network level analysis in addition to the tactical focus of performing location-specific, project-level analysis. This task would include consideration of:

- Current condition of the transportation system and future condition if there is no change in current practices;
- Future condition based on alternative strategies;
- The right time to maintain, preserve, or improve to get maximum useful life from a transportation asset;
- Use preventive fixes or allow an asset to deteriorate to the point of requiring reconstruction;
- Costs and benefits of each decision; and
- Relationship to identified goals and objectives.

The key is the conscious effort required to create and analyze alternatives. It is necessary to focus attention on effectively and efficiently managing and operating our transportation system, rather than merely reconstructing it.

Elements Of Pavement Management

Once a road has been constructed or reconstructed, the condition of the pavement will begin to change over time, due to the effects of weather, environmental factors and traffic loads. Weather factors include the amount of rain/snow, temperatures (particularly extreme heat and cold), humidity, freeze-thaw cycles, exposure to sunlight, etc. Environmental factors include soil types. Traffic load includes some function of traffic frequency and the weight of the vehicles.

There are also combined effects between these two main factors. Heavy and frequent traffic loadings while the pavement is more vulnerable due to severe weather will cause more damage than the same loadings during favorable weather. In addition, several other factors can contribute to the rate at which pavement deteriorates. These include:

- Type, condition, and moisture content of the sub grade soil,
- Type, thickness, and strength of the base materials,
- Timing of preventive maintenance fixes, and
- Quality of construction.

According to the American Association of State Highway and Transportation Officials (AASHTO): "Those who work with pavements know that after a pavement is built, traffic and environmental loadings create unavoidable stress that will eventually reduce the condition of the roads to a point where they will not be usable without maintenance. They also know that early treatment will extend the life of some pavement."[1]

Preventive maintenance programs are designed to extend the life of good pavements by applying low cost, short term treatments. Preventive maintenance projects are low cost projects intended to protect an existing pavement structure, slow the rate of pavement deterioration, and/or correct overall deficiencies in the pavement surface. The benefit of preventive maintenance activity can best be realized if an agency applies treatments to a pavement in good condition. Preventive maintenance treatments cannot be targeted to the worst roads, but must be made to those in fair or good condition which have defects that if left unattended would require much more costly repairs.

The challenge for most agencies is to determine when in the life of a pavement is the best time to apply a preventive maintenance treatment for the maximum benefit. Preventive maintenance is perhaps the single most influential component in the network strategy, that allows an agency to manage pavement conditions. It creates the ability to postpone costly reconstruction or rehabilitation activities, by extending the remaining service life of the original pavement.

A significant benefit of a comprehensive preventive maintenance program is that it gives managers control over future network conditions and funding requirements. By controlling future network conditions, decision makers can anticipate routine maintenance work loads, safety deficiencies, and ride quality needs. Several studies have found that a dollar invested in preventive maintenance will save from $4 to $6 in future reconstruction or rehabilitation costs.

[1] "Executive Summary Report: Pavement Management Guide," AASHTO, November 2001, pp. 1-2.

PAVEMENT DETERIORATION

"The rate at which pavement deteriorates depends on its environmental, traffic loading conditions, original construction quality, and interim maintenance procedures. Poor quality materials or poor construction procedures can significantly reduce the life of a pavement. Therefore, two pavements constructed at the same time may have significantly different lives, or certain portions of a pavement may deteriorate more rapidly than others, due to material or construction problems. On the other hand, timely and effective maintenance can extend the life of a pavement. Crack sealing and seal coating can reduce the effect of moisture in aging of asphalt pavement. With all these variables, it is easy to see why pavements deteriorate at various rates and why we find pavements in various stages of repair … Once significant deterioration begins it is common to see pavements deteriorate rapidly. This is usually due to a combination of loading and the effects of additional moisture. As a pavement ages and additional cracking develops, more moisture can enter the pavement and accelerate the rate of deterioration."

Asphalt – PASER Manual, Transportation Information Center, University of Wisconsin-Madison, 1996, pp. 4, 16.

Pavement Analysis & Overview of PASER

The American Association of State Highway and Transportation Officials (AASHTO) identifies four methods of determining pavement condition.[2]

Surface Distress is damage to the pavement surface. Distress surveys are performed to determine the type, severity, and quantity of observable surface distress.

Structural Capacity deals with the maximum load and the number of repetitions a pavement is predicted to carry. Structural analysis is normally conducted to determine the current pavement load-carrying capacity which can be compared to the capacity needed to accommodate projected traffic.

Roughness (ride quality) is a measure of pavement surface distortion or an estimate of the ability of the pavement to provide a comfortable ride to the users.

Surface Friction or Skid Resistance is the ability of the pavement surface to provide sufficient friction to avoid skid-related safety problems, especially in wet weather.

One of the most critical concerns raised during the Act 51 Transportation Funding Study Committee's deliberations was that there were a myriad of numbers being used to describe the condition of our roads. The reason for the different numbers is related to which of the above methods is being used to determine pavement condition. For instance, the International Roughness Index (IRI) measures roughness. This is what is reported in the TRIP report each year. There is remaining surface life which is used by several agencies including MDOT. There is a pavement condition index or PCI. Both remaining surface life and PCI combine elements of surface distress and structural capacity. And there is PASER, a surface condition analysis used by most of the road agencies throughout Michigan. And while the tendency is to compare these different methods, the truth is they do not measure the same conditions and should not be compared. The Act 51 Transportation Funding Study Committee stressed the need for policy makers to have one method and one method only.

[2] "Executive Summary Report: Pavement Management Guide," AASHTO, November 2001, p. 7.

The Council chose the **Pavement Surface Evaluation and Rating System** (PASER) because it is easy to collect; is of sufficient detail for statewide, network-level analysis; and is the method currently used by most road agencies in Michigan. PASER is a visual survey. It rates the condition of various types of pavement distress on a scale of 1-10. It is based on a system of pavement evaluation developed in Wisconsin and is used by most road agencies in that state.

The Transportation Information Center, University of Wisconsin-Madison has published a series of manuals associated with ratings for different types of surfaces. The manuals are "designed to provide background information on asphalt pavement conditions and causes of distress as well as a simple procedure to rate pavement condition."[3] There are also manuals for concrete, gravel, brick, etc.

PASER is the rating method used by RoadSoft, which is the predominant pavement management software in use throughout Michigan. The Council chose to rate Michigan's roads using the PASER rating method, for the first three years. After that time, a different rating method could be considered.

As mentioned, PASER is a visual, windshield survey. This type of survey is one of the easiest to do and is relatively inexpensive compared to other rating methods. This makes it ideal for small agencies.

While PASER is a subjective method it is based on sound engineering principles. PASER measures "surface distress." It does not measure structural capacity, ride quality or friction.

PASER uses 10 separate ratings. There are different ratings for different surfaces based on the types of deterioration that is evident. The Appendix contains photos from the various PASER manuals for all ratings for asphalt, concrete, and gravel surfaces. For the Council's purposes these ratings have been grouped into three work-related improvement categories.

Routine Maintenance

Routine maintenance is the day-to-day regularly-scheduled activities to prevent water from seeping into the surface such as street sweeping, drainage clearing, gravel shoulder grading, repairing potholes, and sealing cracks. PASER ratings 8, 9, 10 are included in this category. The following pictures show the types of roads that require routine maintenance. This category includes roads that are newly constructed or recently seal coated. They require little or no maintenance. All cracks are sealed tightly.

[3] **Asphalt – PASER Manual**, Transportation Information Center, University of Wisconsin-Madison, November 1996

Capital Preventive Maintenance

Capital preventive maintenance (CPM) is at the heart of asset management. It is the planned set of cost effective treatments to an existing roadway that retards further deterioration and maintains or improves the functional condition of the system without significantly increasing the structural capacity. The purpose of capital preventive maintenance fixes is to protect the pavement structure, slow the rate of deterioration, and/or correct pavement surface deficiencies. Studies have shown that if you invest a dollar today in a CPM fix you can save anywhere from $4 to $6 later in more expensive structural improvements.

Capital Preventive Maintenance

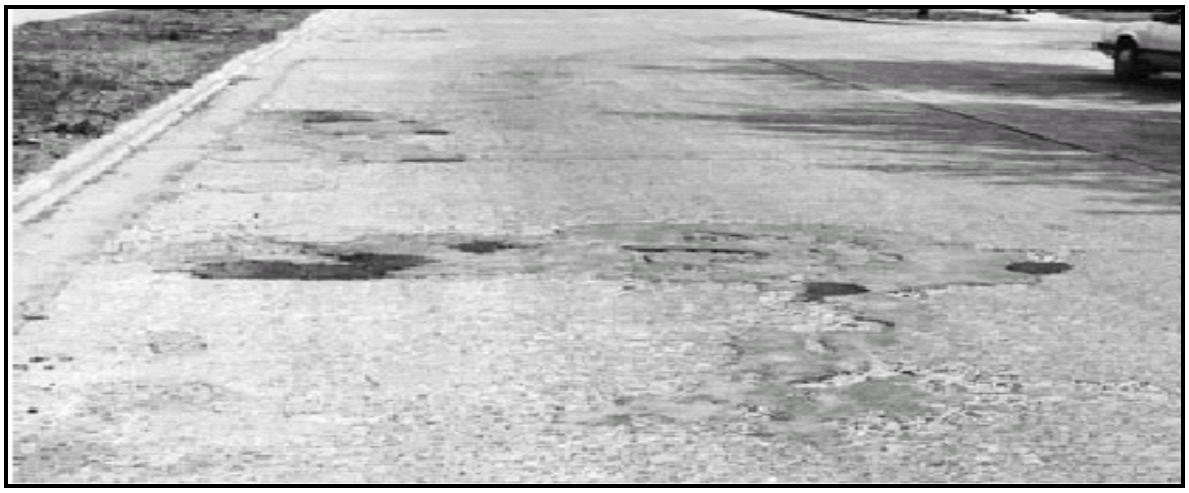
Capital preventive maintenance (CPM) is at the heart of asset management. It is the planned set of cost effective treatments to an existing roadway that retards further deterioration and maintains or improves the functional condition of the system without significantly increasing the structural capacity. The purpose of capital preventive maintenance fixes is to protect the pavement structure, slow the rate of deterioration, and/or correct pavement surface deficiencies. Studies have shown that if you invest a dollar today in a CPM fix you can save anywhere from $4 to $6 later in more expensive structural improvements.

CPM is intended to address pavement problems before the structural integrity of the pavement has been severely impacted. PASER ratings 5, 6, and 7 are included in this category. Typical fixes in this category, include micro-surfacing, chip seals, joint resealing, diamond grinding, crack repairs, minor patching, and seal coating.

In the following pictures we are beginning to see the first signs of wear. The roads still show good structural support but the surface is starting to deteriorate requiring more extensive crack filling or seal coating. Longitudinal cracks or moderate flushing may be occurring. Transverse cracks and block cracking are becoming evident. There may be the start of some spalling along joint edges.

Structural Improvement

Roads with a PASER rating of 1, 2, 3, or 4, are in need of some type of structural improvement such as resurfacing or major reconstruction. Rutting is beginning to take place. Large patches are required. Alligator cracking is evident. Joints and cracks are badly spalled. There are broken slabs requiring complete rebuilding. The following pictures show roads with these types of problems.



For a more extensive view of the types of distresses associated with each PASER rating see the Appendix.